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APPLIED REGIONAL MONITORING OF THE VERNAL ADVANCEMENT AND RETROGRADATION (GREEN WAVE EFFECT) OF NATURAL VEGETATION IN THE GREAT PLAINS CORRIDOR

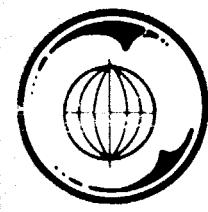
Principal Investigator
 John W. Rouse, Jr.
 Remote Sensing Center
 College Station, Texas 77843

October 1975
 Type II Report for Period May 1975-July 1975

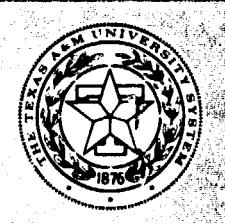
Prepared for:
 Goddard Space Flight Center
 Greenbelt, Maryland 20771

Contract No. NAS5-20796

20540



TEXAS A&M UNIVERSITY
 REMOTE SENSING CENTER
 COLLEGE STATION, TEXAS



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1.0 BACKGROUND & SUMMARY

1.1 Background

This 18 month long study, LANDSAT Follow-On Investigation 20540, is a regional expansion of the LANDSAT-1 investigation entitled "Monitoring the Vernal Advancement and Retrogradation (Green Wave Effect) of Natural Vegetation". The initial study was restricted to evaluating the discrimination of land use patterns and recognizing the phenological development at sites of known plant/soil composition. As expressed in the work statement of contract NAS 5-20796, three tasks are to be addressed during the course of this follow-on study. The first task involves the acquisition and analysis of satellite imagery and computer compatible data from natural vegetation systems in the Great Plains Corridor. The second task involves the acquisition of aerial photography, certain coordinated ground truth data, and environmental data in support of the satellite imagery and data. The third task relates to the correlation and analysis of satellite and support data for testing certain specific hypotheses important in evaluating the feasibility of an operational system for monitoring the status of natural vegetation in the Great Plains. The hypotheses to be tested are:

Hypothesis Number 1--Time is an important factor in the discrimination of broad landforms, soil associations, vegetation types and other natural resources features.

Hypothesis Number 2--The vernal advancement and retrogradation of vegetation (Green Wave Effect) can be discriminated on a regional basis using repetitive multispectral imagery.

Hypothesis Number 3--Vegetation systems parameters are adequately unique to provide a new information source for regional agri-business use.

To test the three hypotheses and to evaluate the application of LANDSAT data within the Great Plains region, the following specific objectives are to be addressed:

Objective Number 1--To develop a data analysis methodology that will facilitate the extension of regional satellite data from the LANDSAT follow-on.

Objective Number 2--To chart the vernal advancement and retrogradation of natural vegetation on a regional basis using LANDSAT data.

Objective Number 3--To record the phenological events and collect specific biological and environmental data using an effective test site network for ground observations.

Objective Number 4--To apply LANDSAT sensor measurements for identification of rangeland vegetation and soil types, measuring short-term and seasonal vegetation reflectance changes, and evaluating the impact of environmental conditions on dominant vegetation.

Objective Number 5--To evaluate the feasibility of using LANDSAT-type data, in conjunction with geographic and climatological parameters for modeling a range forage index and indexes of plant growth conditions.

1.2 Summary

Activities of the second quarter of the contract, May - July 1975, concluded the establishment of the test site network, accomplished the major portion of the ground data and aerial photography collection, and selection of computer processing routines for output products.

To accomplish the second quarter goals the Woodward and Chickasha, Oklahoma cooperative test sites were visited in May. The investigators personally chose both ground sampling locations and other locations for which the ground sampling locations would be representative.

During the first two weeks of June, the period requested by the investigators, NASA/JSC acquired RB-57 aerial photography of the Extended Test Site Area (ETSA)

flight lines plus all other flight lines except those for Mandan, North Dakota. The ETSA photos were utilized by the investigators to choose ground sampling locations.

Ground sampling of the ETSA was carried out in conjunction with the June 15/16 and July 21/22 LANDSAT overpasses. The Throckmorton test, embedded in the ETSA, was sampled coincident with five LANDSAT passes to monitor changes typical of the region. Low and medium altitude photography was acquired in late May/early June coincident with intensive vegetation sampling for site characterization.

Ground sampling was undertaken at each Great Plains Corridor cooperative site at least two times during the quarter. Weather conditions (cloud cover) determined the sampling dates for each site.

Methods for graphically displaying the ETSA by the use of Texas A&M's IBM 360/65 and an associated plotter have been developed and are currently being implemented. Level contouring using mean temperatures supplied by weather stations in the area as data are being generated to see the climatological pattern over the ETSA.

Dissemination of technical information through presentations and publications was accomplished during

the quarter. A paper, to be published in the proceedings was presented at the NASA sponsored Earth Resources Survey Symposium in Houston. An unpublished presentation was given to interested users during the quarter at Midland, Texas.

1.3 Organization of the Report

The body of this Type II progress report is organized along the lines suggested in the contract statement of work. Section 2 (Accomplishments and Problem Areas) discusses details of the approach taken on this project and the tasks undertaken during the quarter for both data acquisition and analysis. It also delineates problems encountered and the effect they had on project activities, recommendations concerning the project and accomplishments expected to occur during the next quarter.

Section 3 (Significant Results, Publications and Presentations) relates significant results obtained and lists publications and presentations distributed during the quarter. Section 4 (Funds Expended and LANDSAT Data Status) presents the total expenditures during the quarter towards this project from three sources: TAMU contract funds; TAMU matching funds; and NASA high-flight photography and LANDSAT data accounts at both the EROS Data Center and the ASCS Aerial Photography Field Office. The LANDSAT

data expenditures are treated separately from the others and in the manner specified by the contract. Section 5 (Aircraft Data Usage) describes the ways in which aircraft data supplied by NASA have been utilized in the project activities.

2.0 ACCOMPLISHMENTS AND PROBLEM AREAS

2.1 Accomplishments During the Reporting Period

During the first month of the second quarter, the Oklahoma test sites were visited; similar to the northern site visits during the previous quarter. Additional sampling sites were established, and sampling procedures for the growing season were detailed and discussed with the test site cooperators.

Potential ETSA sampling locations, selected from LANDSAT imagery and resource map evaluations, were also visited in conjunction with the Oklahoma trip. In the field, suitability determinations were made for these locations.

On June 4, the ETSA and Chickasha, Oklahoma flight lines were flown by NASA. Three of these lines contained considerable cumulus cloud cover in the southern half of the area. The Woodward, Oklahoma and Hays, Kansas flight lines were flown on June 5 under clear conditions. On June 12, NASA acquired the photography for Sand Hills, Nebraska; Cottonwood, South Dakota; and College Station, Texas. Some of this photography was of poor quality due to cloud cover within the target area.

RSC personnel traveled to Johnson Space Center in Houston on June 15 and reviewed film of the June 4 ETSA photography to make final sampling location selections. The next day, an RSC ground sampling crew was dispatched to the ETSA (Figure 2-1) to begin collecting vegetation data and other information needed to correlate with the satellite overpass which occurred the two days previous (June 15 and 16). The 17 primary sampling locations (Figure 2-2) were sampled again beginning on July 21 in conjunction with LANDSAT-2 coverage of the ETSA on July 21 and 22.

In addition to sampling the ETSA sampling locations on two dates, the Throckmorton test site was sampled coincident with five LANDSAT overpasses during this reporting period to provide a "continuous" monitoring of vegetation conditions and changes typical of the region. Intensive vegetation sampling was also conducted at the Throckmorton test site in late May and early June to provide basic information on vegetation and soil conditions and resultant LANDSAT-measured spectral reflectance. Low and medium altitude aerial photography was acquired coincident with this sampling.

Ground sampling was also undertaken at the other Great Plains Corridor test sites during this reporting



Figure 2-1. Location of the 6 1/4 million hectare
(15 1/2 million acres) Extended Test
Site Area in the Rolling Plains of
Texas and Oklahoma.

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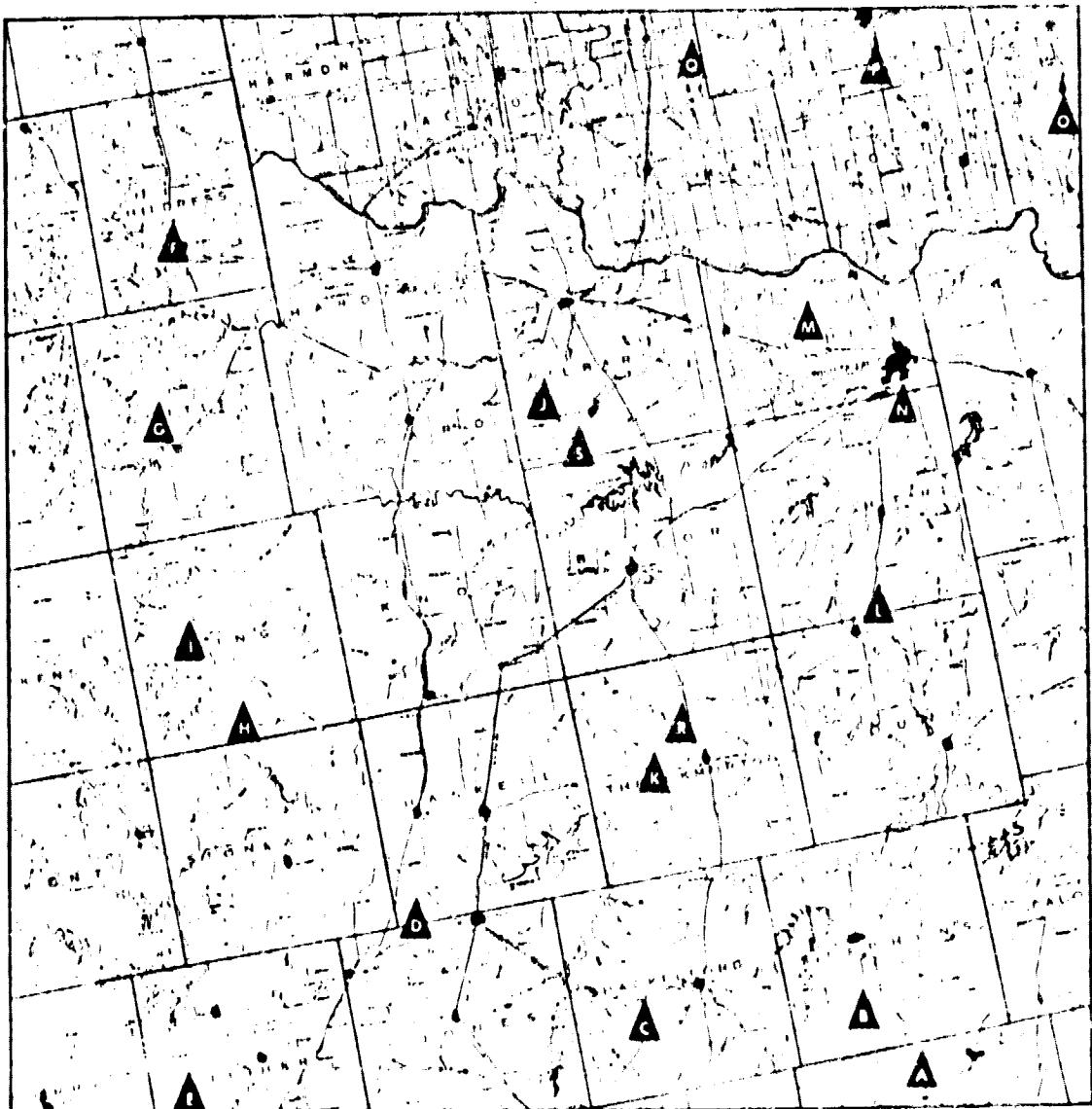


Figure 2-2. Permanent sampling locations in the Rolling Plains Extended Test Site Area (ETSA).

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period. Each cooperating station sampled the designated sampling sites two or three times during this reporting period. Weather played a big factor in scheduling the sampling dates at most locations.

Methods for graphically displaying the ETSA by the use of Texas A&M's IBM 360/65 and an associated plotter have been developed and are currently being implemented. Isoline contouring using mean temperatures supplied by weather stations in the area as input data are being generated to study the climatological pattern over the ETSA.

The main program takes as input a value, either temperatures or any other parameter, or combination of parameters such as soil type and elevations, along with an x and y coordinate, placing it within the ETSA grid. The points not specified by the input data set are then filled in by a three dimensional n^{th} order spline fitting routine. The resulting matrix is then contoured and plotted.

2.2 Problem Areas

Ground data collection was originally scheduled to begin coincident with a LANDSAT-2 overpass in mid-May. Cool, wet weather throughout the Great Plains region in the early spring, however, delayed spring greenup by at least two weeks. Consequently, the first sampling period was re-scheduled for late May and early June.

The clouds that had been producing the unusually wet conditions that persisted throughout June and July in the Extended Test Site Area also resulted in less than desirable satellite overpass conditions in this area. It is believed, however, that sufficient cloud-free data is available to relate to the ground data that was acquired to achieve the project objectives.

In conjunction with the ground sampling in the ETSA in late July, an attempt was made to acquire the medium altitude aerial photography over the sampling locations. After photographing only three of the locations, the airplane developed engine trouble, which terminated the mission.

Many project activities, such as final resource map preparation, extension site location in the GPC test areas for LANDSAT MSS data processing, and secondary site selection in the ETSA are being delayed because the NASA high-flight aerial photography (acquired June 4-12) has not been received. The microfilm copy from which photos will be selected and retrospective orders placed, had not been received by the end of the reporting period.

The acquisition of weather data from stations in the ETSA has been slow as the data is in the form of monthly reports from the U.S. Department of Commerce and its col-

lection is slow and tedious. Computer compatible tapes from NOAA are available with the needed information, but the data on them are unverified and therefore unreliable.

Creating a complete accurate grid from a sparse matrix by spline fitting is a problem in that, the given points are distorted to fit a three dimensional surface. That is, in order to produce smoothed isolines some actual data points are, in effect, ignored. Comparing input data to the resultant point on the contour shows up to a 15 to 20 percent difference. In general, the better behaved the input data is, the smoother and more accurate the function will be. In lieu of well behaved input data a different function is being looked at for producing the data points filling in the matrix to be contoured.

2.3 Recommendation

No recommendations based on project results can be made at this early stage of the investigation.

2.4 Accomplishments Expected During the Next Quarter

The last of the scheduled ground truth data collections will take place in the ETSA and at the GPC test sites in late September and early October to document the total season's production minus grazing removal and to monitor the phenological changes since the summer sampling.

Medium altitude aerial photography will be acquired for ETSA sampling locations. Ground truth data will be reduced and statistically analyzed. Weather data will be compiled and test site summaries prepared.

Upon receipt of NASA high-flight aerial photography microfilm, photos will be selected and ordered. Once the aerial photography has been received, the ETSA and GPC test area extensions sites will be selected and mapped.

ETSA sampling locations, extension sites and weather station locations will be computer referenced in the Universal Transverse Mercator (UTM) notation system for information compilation, extraction, and analysis with LANDSAT MSS data.

Effort is under way to discover or create a method of filling in a grid in a controlled manner given a sparse matrix of data. This is done in order that the points given as input and the same points in the final output product will be as nearly the same number as possible.

A three dimensional program is being developed to display graphically the topographic features drawn by the contouring program. The program plots the function created by the same routine that does the level contouring.

3.0 SIGNIFICANT RESULTS, PUBLICATIONS AND PRESENTATIONS

3.1 Significant Results

No significant results were obtained from analysis during this quarter. The period was spent obtaining data and methods for analysis.

3.2 Publications and Presentations

A paper and an unpublished presentation were produced during the second quarter, May - July 1975. Both concerned techniques and results of the LANDSAT-1 Great Plains Corridor rangeland study and the technical approach of the Follow-On contract work.

J. W. Rouse, Jr. presented a paper entitled "Monitoring Vegetation Conditions from LANDSAT for Use in Range Management" at the Earth Resources Survey Symposium. The paper presented results of the LANDSAT-1 Great Plains Corridor rangeland study and described the approach being taken under the present LANDSAT Follow-On contract.

D. W. Deering gave a semi-technical presentation concerning the techniques and results of the LANDSAT-1 contract work. The talk was given on May 2, to the Southwest Chapter of the American Right of Way Association's land use planning seminar in Midland, Texas.

4. FUNDS EXPENDED AND LANDSAT DATA STATUS

4.1 Total Expenditures To-Date

Expenditures under this contract are divided here into three categories for the purpose of discussion: TAMU contract expenditures; those from TAMU matching funds; and NASA expenditures. The items considered under NASA expenditures as accountable directly to this project are those for LANDSAT imagery, LANDSAT CCT data and the High-Flight aerial photo on accounts set up with the EROS Data Center and the ASCS Aerial Photography Field Office. Table 4-1 gives the total expenditure for the quarter under each of the categories.

4.2 Data Status

Three data accounts have been established for this project. Both a LANDSAT imagery account (20540) and an aircraft imagery account (20540 AC) have been set up with the ASCS Aerial Photography Field Office. A LANDSAT CCT data account is in effect with the EROS Data Center. Table 4-2 lists the budgeted amount, the amount ordered, and that received for each account during the quarter.

TABLE 4-1. Second Quarter Expenditures

	Total Budget	Balance Forwarded	Expenditures This Quarter	Balance
TAMU Contract	\$97,000.00	\$88,317.98	\$13,468.01	\$74,849.97
TAMU Matching Funds	\$58,700.00	\$55,439.00	\$ 3,261.00	\$52,178.00 (Ave./Mo.)
NASA Data Accounts	\$29,200.00	\$28,506.00	\$ 380.00	\$28,126.00

TABLE 4-2. Data Expenditure Tabulation

Account	Value of Data Allowed	Value of Data Ordered	Value of Data Received
ASCS LANDSAT			
Imagery (20540)	1800	180	180
ASCS Aircraft			
Imagery (20540AC)	2640	- 0 -	- 0 -
EROS CCT			
Data (GB0540)	24800	200	200

5.0 AIRCRAFT DATA USAGE

As reported in section 2.0 above, NASA high-flight aerial photography of all flight lines was acquired during the month of June. The Extended Test Site Area (ETSA) situated in north Texas and southern Oklahoma was flown on June 4. The film was processed and was initially previewed at JSC by TAMU personnel on June 15. An assessment was made of the success of the photography. Considerable cumulus cloud cover had existed over the southern half of three of the flight lines, but it was deemed unnecessary to re-fly those lines.

The photography was utilized during the initial viewing at JSC to select ground sampling locations in the ETSA. To select them the TAMU personnel found locations which were comparable on the photos to ground sampling locations previously chosen by a ground survey. On the next day, June 16, a ground sampling crew from the Remote Sensing Center was sent to the ETSA and began collecting vegetation data and other information from the locations selected from the aerial photos. The ground sampling locations selected in this way were found to be satisfactory.